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(पहला पुनरीक्षण)

Indian Standard

GUIDELINES TO ESTABLISH A VALUE ENGINEERING ACTIVITY

(First Revision)

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
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Management and Productivity Sectional Committee, MSD 4

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Management and Productivity Sectional Committee had been approved by the Management and Systems Division Council.

Value engineering is a function oriented team approach aimed at providing value in a product, system or service. The methods and techniques of value engineering can be used to improve existing products, components, systems, manufacturing methods/processes, designs as well as in building/project construction and other activities.

The term value engineering is known by different names, such as, value analysis, value management, value methodology and others.

Larry Miles, the father of value engineering, originally called it value analysis. At the time of implementation of Miles method in the U S Navy it was called value engineering because the Navy could hire additional engineers but not analysts.

In this standard, the term value engineering has been used, as it is better understood. The standard also does not make any distinction between the terms value analysis, value engineering, value management and value methodology.

This standard was first published in 1986. The revision of this standard was considered essential as a lot of developments had taken place in the last decade in the techniques of value engineering. Moreover, the terminology used in this field had also undergone a change over the years, many new terms have been adopted and some terms have been discarded. As such this revised version takes into account the latest terminologies and techniques in the field of value engineering.

This revised version has been divided into three sections, namely:

Section 1	What is value engineering?
Section 2	Glossary of terms in value engineering
Section 3	Adoption and execution of value engineering in an organization

This standard is intended primarily as a guide to persons/organizations wishing to implement value engineering. It is hoped that this standard will help in establishing a generally recognized usage of terms and in eliminating confusion regarding actual implementation of value engineering techniques in different organizations and in different applications.

While preparing this standard, assistance has been drawn from the following documents:

BS EN 1325-1 : 1987	Value management, value analysis, functional analysis vocabulary: Part 1 Value analysis and functional analysis
AS/NZS 4183 : 1994	Value management

Function analysis systems techniques — The basics, SAVE-International

Function logic models, SAVE-International

Function relationships — An overview, SAVE-International

Monograph function — Definition and analysis, SAVE-International

Value methodology standard, SAVE-International

The composition of the Committee responsible for formulation of this standard is given in Annex F.

Indian Standard

GUIDELINES TO ESTABLISH A VALUE ENGINEERING ACTIVITY

(First Revision)

SECTION 1 WHAT IS VALUE ENGINEERING?

1 SCOPE

This section describes the concept of value engineering and its scope of application.

2 REFERENCES

The following standards contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
9990 : 1998	Glossary of terms in terotechnology (*first revision*)
13174	Life cycle costing:
(Part 1) : 1991	Terminology
(Part 2) : 1994	Methodology

3 VALUE ENGINEERING CONCEPT

3.1 Value engineering (VE) is a discipline comprising a series of creative techniques aimed at an organized systematic effort directed at analyzing the function(s) of products, services, equipments, processes or procedures for the purpose of accomplishing all the required functions at the lowest total cost, which expression covers not only initial cost, but also ownership cost covering operating/maintenance/disposal costs, etc, throughout the desired or specified life cycle of the article or subject under study.

3.2 Value engineering is basically a team effort. It aims at promotion of value awareness and raising the level of professional competence and technological excellence in the organization. Value engineering not only aims at cost reduction but also cost-effectiveness which in turn enhances the value and provides competitive advantage.

3.3 Value engineering techniques can be applied wherever cost is proposed or likely to be incurred in terms of money, skills/expertize, energy or other resources. In other words, this will cover practically every area of human activity and value engineering can be considered applicable to all of them.

More specifically, value engineering is applicable to hardware, building or other construction projects and to soft areas, such as manufacturing processes, administrative and management systems, office procedures, books and forms and computer software costs.

3.4 In case of once through projects such as civil engineering works (for example, buildings, highways, water/air/effluent treatment plants, etc) and engineering projects such as product design, greater benefits from the application of VE can be obtained by application of these techniques at the early design stages. Adequate data collection in such studies is essential together with in-depth involvement of the agencies dealing with the finance, design, construction and use of the project. A project may require several teams to work simultaneously on different aspects such as, structural design, lay-out, sub-system services, etc.

3.5 Value engineering studies in soft areas are those which concern manufacturing processes and administrative procedures. A sequence flow-chart of activities and times using standard industrial engineering techniques is essential. Details of material loss, low yield, wastages, rejection, re-work, loss of man/machine-hours, etc, together with their costs, are equally essential as part of the data to be collected during the information phase of the value engineering study.

3.6 Value engineering results in the increased use of alternative less expensive material, cheaper design, weight reduction, new methods of manufacturing, indigenization, etc, to give the same or better performance, quality and efficiency at a lower overall cost.

In order to produce a product or service to be competitive in the open market, the best value is determined by two considerations, namely, function and cost of product.

Value = Function/Cost = Worth/Cost = Utility/Cost

Value of a product or service can be enhanced either by increasing the function or decreasing the cost or both while maintaining the performance quality and reliability.

3.7 There is practically no limit to the field of application of value engineering at any point in the life cycle of a product. VE is a customer oriented function-cost approach which may lead to cost avoidance not merely cost reduction. The differences between conventional cost reduction techniques and value engineering are given in Annex A.

4 APPLICATIONS OF VALUE ENGINEERING

4.1 Typical applications of value engineering include:

a) Construction :
   1) Project concept;
   2) Customer requirements/specifications;
   3) Site selection;
   4) Design proposals;
   5) Material selection;
   6) Construction programmes;
   7) Construction methods; and
   8) Facility maintenance.

b) Manufacturing :
   1) Product concepts;
   2) Customer requirements/specifications;
   3) Design proposals;
   4) Material selection;
   5) Manufacturing methods; and
   6) Product marketing.

c) Systems, services and processes :
   1) Concepts;
   2) Customer requirements/specifications;
   3) Design proposals;
   4) Implementation procedures;
   5) Monitoring procedures;
   6) Maintenance procedures; and
   7) Strategic planning.

d) Management decision making in circumstances when value engineering is used as a group/team problem-solving process on issues such as :
   1) Strategic planning;
   2) Policy formulation;
   3) Asset management;
   4) Supply chain management;
   5) Maintenance management;
   6) Marketing;
   7) Administration;
   8) Overheads;
   9) Capital and recurrent budgets;
   10) Organization design;
   11) Cycle time management;
   12) Programming development; and
   13) Information technology.

e) Value engineering incentive clauses (VEIC) :

   Value engineering incentive clauses (VEIC) are contract clauses which offer financial incentives to contractors by a sharing of the savings generated by the contractor and by contractor-initiated changes in specifications, scope of work or methodology. It encourages contractors to suggest contract changes, which reduce the overall cost to the customer. Here, the term contractor is used in a generic sense which includes suppliers, vendors, etc.

   Such changes, which lead to more economical ways of carrying out the work while still providing the essential functions required by the customer, invariably include the elimination or modification of requirements found to be in excess of actual needs.

5 OBJECTIVES OF VALUE ENGINEERING

The objectives of VE are to increase:

a) Profitability,
b) Competitiveness,
c) Resource utilization,
d) Customer satisfaction, and
e) Job satisfaction, etc.

These can be achieved by:

a) Finding out functions and their costs,
b) Identifying high cost functions,
c) Eliminating unnecessary functions,
d) Helping to establish alternate ways of providing the needed function by creative techniques, and
e) Selecting the most valuable alternative for implementation.

SECTION 2 GLOSSARY OF TERMS IN VALUE ENGINEERING

6 SCOPE

This section is intended to define and explain the terms commonly used in value engineering.

7 TERMINOLOGY

7.1 Acquisition Cost — The price paid to acquire goods and services not produced internally by an organization.

7.2 Aesthetic Function — A function attributable to delighting the user such as styling or other appearances but which may not necessarily contribute to the performance. This could be the basic function in some cases.

7.3 All the Time Function — That function which happens all the time, even when the item under study is not in use.

7.4 Annualized Cost — An economic technique to convert any defined set of present value costs to an equivalent uniform annual amount for a fixed period.

7.5 Attribute Listing — Listing of the main features or parameters for performing the desired function. Such a listing, if creatively deliberated on, can increase the number of ideas to solve a problem.

7.6 Basic Function — The specific reason for which the product, service, process or system is designed and made. For example, the basic function of a bulb would be 'produce light'.

7.7 Brainstorming

a) *Brainstorming, Individual* — Creating ideas alone, by oneself without active interaction with any one else.

b) *Brainstorming, Group* — Creating ideas collectively by a group or team, with free interaction among members but without ridicule or negative criticism.

7.8 Breakeven Point — The quantity where two or more alternatives are equal in cost.

NOTES

1 In the context of finance, breakeven point means the quantity where the cost of producing a product is equal to the income from sales of that product.

2 In the context of procurement, breakeven point means the quantity where two competing acquisition alternatives are equal in cost.

7.9 Checklist — A list containing points serving to provide ideas/clues/leads for further follow up and development. It is used in the search for new ideas.

7.10 Costs — The monetary equivalent for every type of resource being expended or expected to be expended in order to achieve a single function or where applicable, a group of functions together making up a product, process or project designed to satisfy the specific needs of the user or customer.

7.11 Cost Model — The hierarchical structure to represent the cost and the worth of a product/process/project/service.

7.12 Cost Value — The monetary equivalent of the current resources expended to achieve a function measured in rupees.

7.13 Crawford Slip Writing — A creative technique involving rapid writing of one idea per slip in a severely restricted time frame (usually 3 min) and without permitting any talk or discussion. It is designed to eliminate tendencies to criticize ideas and increase the number of ideas.

7.14 Creativity — A mental process which encourages uninhibited thinking and ideation without restraints and ignoring (temporarily) the difficulties or problems that may be faced in implementing those ideas.

7.15 Critical Function — Every function appearing in the critical path in FAST diagram.

7.16 Critical Path — The line(s) connecting all functions in the FAST diagram prepared during a VE study.

7.17 Critical Path Function — A set of functions that meet the how and why logic on a FAST diagram.

7.18 Dependent Function — A function that depends on a higher order function for its existence. Lower order functions, to the right of each other on a FAST diagram that are successfully dependent on the one to its immediate left for existence. Lower order functions on a function hierarchy model that appear immediately below the function it supports.

7.19 Design-to-Cost (DTC) — Design-to-cost (DTC) is an iterative process to evolve a design to achieve a prescribed cost target.

7.20 Development Cost — The cost to develop and test a VECP.

7.21 Direct Cost — Cost that is specifically identifiable with and attributable to the production of a product.

7.22 Direct Labour Cost — The amount expanded for salaries and wages to provide a product. It may include fringe benefits associated with that labour cost. Often referred to as hands on labour cost.

7.23 Discount Rate — The rate of interest reflecting inflation and the time value of money that is used in the discount formula to convert costs and benefits occurring at different times to a common time.

7.24 Essential Cost — All costs necessary to provide basic function.

7.25 Esteem Function — *See* 7.2.

7.26 Esteem Value — The monetary sum a user is willing to pay for functions providing prestige, appearance and/or other esteem functions.

7.27 Exchange Value — The monetary sum for which a product can be traded.

7.28 Facilitator — An experienced person trained in appropriate methodologies responsible for guiding the team or group through the VE job plan and for creating a highly motivated climate within a VE study team.

7.29 Fixed Cost — Costs that do not vary with the volume of business.

7.30 Function — Usually defined in two words, namely, a verb and a noun, it indicates the services provided and the purpose/use desired by the customer.

Example

Item	*Function Verb*	*Noun*
Electric Bulb	Produce	Light
Tap	Control	Flow
Pencil	Make	Mark
Bottle	Hold	Fluid

7.31 Function Analysis — An analysis for identifying the various functions of products, processes or systems using a verb and a noun. It involves determining relative importance of these functions, identification of redundant functions and value gap.

7.32 Function Cost — The part of product cost allocated to functions performed by the product.

7.33 Function Analysis System Technique (FAST) — A horizontal chart depicting functions within a project, with the following rules:

a) The sequence of functions on the critical path proceeding from left to right answer the question 'How is the function to its immediate left performed?'
b) The sequence of functions on the critical path proceeding from right to left answer the question 'Why is the next function performed?'
c) Functions occurring at the same time or caused by functions on the critical path appear vertically below the critical path function.
d) The basic function of the study is always farthest to the left of the diagram of all functions within the scope of the study.
e) Two other functions are classified:
    1) *Highest order* — The reason or purpose that the basic function exists. It answers the 'why' question of the basic function, and is depicted immediately outside the study scope to the left.
    2) *Lowest order* — The function that is required to initiate the project and is depicted farthest to the right, outside the study scope. For example, if the value study concerns an electrical device, the "supply power" function at the electrical connection would be the lowest order function.

7.34 Function Model — The hierarchical structure to represent the cost and worth of a function.

7.35 Function Worth — The lowest cost that is required to perform a function.

7.36 Gordon Technique — A creative technique in which only the team leader knows the real subject of the creative exercise and the team members are encouraged to generate ideas without being inhibited by knowledge of the project under study or the performance level for which the ideas are required.

7.37 Higher Order Function — The function immediately to the left of a dependent function on a FAST diagram.

7.38 Highest Order Function — *See* 7.33.

7.39 Implementation Cost — Costs to incorporate and implement approved change(s). These costs may include both the developers and users costs.

7.40 Independent [or Supporting Function(s)] — Functions that do not depend on another function, or methods selected to perform that function. Independent functions are located above the critical path function(s) and are considered secondary, with respect to the scope, nature and level of the problem, and its critical path.

7.41 Indirect Cost — Expenses not directly associated with specific products, operations or services.

NOTE — This definition has been taken from IS 9990, in which this term has been indicated as 'Indirect costs'.

7.42 In-House VE — VE work carried out within an organization by its own personnel who may be either qualified VE managers or members of different departments though not yet actually qualified as experts in VE. The study may be with or without outside specialists.

NOTE — The term in-house VE is used to differentiate from VE work done by a contractor or vendor.

7.43 Input Function — It is a lowest order function in a FAST diagram immediately to the right of the right scope line.

7.44 Job Plan — A structured sequential approach to conduct a VE study.

7.45 Labour Cost — Expenses for labour including wages, taxes, allowances, welfare and overheads.

NOTE — This definition has been taken from IS 9990.

7.46 Life Cycle Cost (LCC) — It covers all the costs from project conception to final scrapping and disposal and includes all costs of operation, repairs, maintenance, energy consumption, rentals, insurance, etc, in addition to the initial costs of development and/or acquisition, all discounted to the same point in time.

NOTE — This definition has been taken from IS 13174 (Part 1).

7.47 Life Cycle Costing — A comparative assessment of competing alternatives based on their respective life cycle costs over their economic life.

7.48 Lower Order Function — Function to the right of the basic function in a FAST diagram. In a function hierarchy model the functions below the basic function are lower order functions.

7.49 Lowest Order Function — *See* **7.33** e) 2) and **7.43**.

7.50 Manufacturing Cost — The total of operating costs chargeable to production of the given product. Includes direct expenses such as material, labour, and shop overheads.

NOTE — This definition has been taken from IS 13174 in which this term has been indicated as 'Manufacturing costs'.

7.51 Material Cost — The cost expended for raw or purchased materials needed to produce a product.

NOTE — Sometime it includes the cost of receiving, inspecting and warehousing.

7.52 Matrixing — A tabular or graphical method to arrange two sets of data for matching with each other, for example, different methods of producing light on the X-axis and different ways of increasing life or reliability on the Y-axis. Such a combination increases the number of ideas possible during the creativity phase of a VE study.

7.53 Morphological Analysis — A graphical method to gather three sets of data for matching with one another, for example, different methods of producing light on the X-axis, different ways of increasing life or reliability on the Y-axis and different raw materials used on the Z-axis. The matrix thus becomes three-dimensional and, therefore, acquires volume or shape. This combination further multiples the ideas manifold.

7.54 Non-recurring Cost — Cost that occurs or is expected to occur only once such as costs associated with the development, testing and implementation of value improvement ideas.

7.55 Overhead Cost — A cost or expense inherent in the performing of an operation, that is, engineering construction, operating or manufacturing which cannot be charged to or identified with a specific part of the product, or asset and, therefore, must be allocated on some arbitrary basis believed to be equitable, or handled as a business expense, independent of the volume of production.

NOTE — This definition is same as the definition given to the term 'Overhead' in IS 13174 (Part 1).

7.56 Ownership Cost — The cost to acquire, operate, maintain, repair, and dispose of the product during its period of use.

7.57 Recurring Cost — Costs that reoccur on a periodic basis throughout the life of a project.

NOTE — This definition has been taken from IS 13174(Part 1) in which this term has been indicated as 'Recurring costs'.

7.58 Required Function — A function describing a characteristic which is absolutely necessary to perform the user function.

7.59 Required Secondary Function — A function, that is, necessary to the performance of a product based on the current method of achieving the basic function.

7.60 Road Blocks — The objections and problems most often raised by people to stall or obstruct any improvement programme or indeed any change.

7.61 Scope — The limits or terms of reference of a value engineering study. This is usually decided by the management; if not, by the team themselves in the course of a VE study.

7.62 Scope Lines — Two vertical broken lines on either side of a FAST diagram indicating precisely the area or scope of a VE study.

7.63 Secondary Function — A function that supports the basic function and results from the specific design approach to achieve the basic function. As methods or design approaches to achieve the basic function are changed, secondary functions may also change. Secondary functions may be classified as required, aesthetic, unwanted or sell.

7.64 Sell Function — A function that provides primarily aesthetic/esteem value or enhances appeal to the user/customer.

7.65 Standard Cost — A benchmark cost which is based on pre-established measures that are expected to remain unchanged over an extended period of time. Should be periodically reviewed. Usually fixed for production or construction items or operations.

NOTE — This definition has been taken from IS 13174 (Part 1).

7.66 Supporting Function — A function that increases acceptance and assures dependability, convenience, and user satisfaction.

7.67 Total Cost — *See* **7.46**.

7.68 Unnecessary Cost — That portion of the cost of a product which does not contribute to basic function, required performance or marketability.

7.69 Unnecessary Function — A non-essential function not contributing to the utility or desirability of a product as an adjustable seat in a city public transport bus.

NOTE — Objective of VE study is to identify such unnecessary functions and eliminate them.

7.70 Unwanted Function — A negative function caused by the method used to achieve the basic function as the heat generated from lighting.

7.71 Use Function — *See* **7.90**.

7.72 Use Value — The lowest overall cost associated with performing those functions which actually carryout the work or service desired by a user.

7.73 User Function — Function for which a user buys the product as the cooling system in a refrigerator.

7.74 Value — The lowest cost to reliably provide the required functions at the desired time and place with the essential quality and other performing factors to meet user requirements.

NOTES

1 Value can also be arithmetically arrived at as a ratio of worth to cost; that would tend towards unity for best value.

2 Value can be enhanced by improving the functions that are desired by the customers even at an increased cost.

7.75 Value Analysis — *See* 7.77.

7.76 Value Engineer — One who applies value engineering methodology to study and search for value improvement.

7.77 Value Engineering — The systematic application of recognized techniques which identify the functions of the product or service, establish the work of those functions, and provide the necessary functions to meet the required performance at the lowest overall cost. The standard uses the term value engineering as being synonymous with term 'value analysis', 'value management' and 'value methodology'.

NOTE — Value engineering can also achieve enhanced value by improving the functions that are desired by the customer even at an increased cost.

7.78 Value Engineering Change Proposal (VECP) — A proposal seeking to change the existing design, process or procedure to improve value. It invariably includes before and after cost and performance details to support the value improvement claimed.

7.79 Value Engineering Incentive Clause (VEIC) — Usually incorporated to enable contractor's VE work and lay down the procedure for sharing of costs and benefits.

7.80 Value Gap — The difference between the function cost and function worth (FW) expressed as, Value Gap = $FC - FW$. The value gap indicates the potential saving or benefits to be aimed at during a VE study.

7.81 Value Index — The monetary relationship of function worth to function cost (FC) expressed as VI = FW/FC, where VI is never greater than unity.

7.82 Value Management — *See* 7.77.

7.83 Value Management Brief — A statement, endorsed by the management/client that establishes what the VE study team is required to achieve.

7.84 Value Methodology — *See* 7.77.

7.85 VE Consultant — A VE specialist who provides VE services to diverse organizations, departments and companies.

7.86 VE Specialist — A qualified and experienced individual who applies value engineering to study and search for value improvement.

7.87 VE Study (Value Engineering Study) — The application of value engineering to a product, service, project, process or system.

7.88 VE Study Team — The multidisciplinary team of participants, committed to the common goal of working through the job plan to successfully bring a value engineering study to completion.

7.89 VE Team Leader — Person who has the knowledge, experience and personality to organize, communicate, manage and coordinate a VE team and facilitates to motivate the team for implementation of recommendations. VE team leader is appointed for managing this function.

7.90 Work Function — A function that assists in making the product perform and provides use value as the handle in an electric iron.

7.91 Worth — The lowest cost to accomplish a function, even if it be in a very elementary manner not comparable in quantity, reliability or life to the same function required in the item or project under study.

SECTION 3 ADOPTION AND EXECUTION OF VALUE ENGINEERING IN AN ORGANIZATION

8 GENERAL

8.1 Value engineering may be applied to management decision making at any level of an organization. Specifically, it may be applied to projects, products, systems, services or processes.

8.2 In each of these cases value engineering may be used to examine new schemes as well as existing ones. The process may be applied at any stage in a life cycle of project, product, system, service or process and may be applied a number of times in that life cycle to ensure continuous value improvement.

8.3 It has been demonstrated that the highest potential benefit from value engineering occurs at the earliest stages in the life of a scheme. In particular, benefit is gained where studies are held prior to financial commitments being made or at least prior to scheme implementation. A series of value engineering studies may be held at various times on the same project during concept, design and construction/ manufacture.

9 SCOPE

This section deals with actual adoption and execution of value engineering in an organization.

10 VALUE ENGINEERING APPLICABILITY

10.1 The value engineering (VE) can be applied wherever cost and/or performance improvement is desired. That improvement can be measured in terms of monetary aspects and/or other critical factors such as productivity, quality, safety, time, energy, environmental impact, reliability and durability. VE can beneficially be applied to all business processes in particular and all areas of human endeavour in general.

10.2 The value engineering is applicable to hardware, building or other construction projects, and to soft areas such as designing, engineering and manufacturing processes, health care and environment services, programming, management systems and organization structure.

10.3 For civil, commercial and military engineering works such as buildings, highways, factory construction, and water/sewage treatment plants, which tend to be one-time applications, VE is applied on a project to project basis. Since these are one-time capital projects, VE must be applied as early in the design cycle as feasible to achieve maximum benefits.

10.4 For large or unique products and systems such as military electronics, ship building or specially designed capital equipment, VE is applied during the design cycle to assure meeting of goals and objectives. Typically a formalized value study is performed after preliminary design approval but before release to the build/manufacture cycle. VE may also be applied during the build/manufacture cycle to assure that the latest materials and technology are utilized.

10.5 VE can also be applied during planning stages, and for project/programme management control by developing function models with assigned cost and performance parameters. If specific functions show trend towards beyond control limits, value studies are performed to assure the function's performance remains within the control limits.

10.6 For guidelines to select projects (*see* Annex B).

11 GUIDELINES FOR FORMULATING VALUE ENGINEERING STUDY TEAM

11.1 A key to the successful application of a value study is the skills and experience of those applying the methodology. While the methodology can and often is, used by individuals, for significant projects it has been proven that a well organized team obtains the best value for effort performed.

11.2 The team leader performs a key role and is a significant factor in the degree of success. The team leader must have thorough training in both the value engineering and team facilitation. The requirements include strong leadership, communication skills, and experience working with users/clients.

11.3 The size and composition of the team is project dependent. The members should represent a diverse background and experience that incorporates all the knowledge required to fully cover the issues and objectives of the project. Typically these include cost, estimating, procurement/materials and those technical disciplines unique to the project such as design, manufacturing, construction, environmental, and marketing. The team shall preferably have at least one member who is not directly concerned with the project so that he can have a detached view on the subject.

11.4 It is most advantageous for the team leader, or a team member, to implement the approved value proposals at study completion.

11.5 Decisions based primarily upon one technical discipline will often have significant effects on other disciplines within the project. In addition to being technically competent, team member selection should include individuals who represent the range of disciplines and end users the study results will impact.

12 VE STUDY PROCEDURE

12.1 The value engineering study uses a systematic procedure called job plan (*see* Fig. 1). The job plan outlines specific steps to effectively analyze a product or service in order to develop the maximum number of alternatives to achieve the product's or service's required functions. Adherence to the job plan will better assure maximum benefits while offering greater flexibility.

12.2 The VE job plan covers three major periods of activity: Pre-study, the Value study, and Post-study. All phases and steps are performed sequentially. As a value study progresses new data and information may cause the study team to return to earlier phases or steps within a phase on an iterative basis. Conversely, phases or steps within phases are not skipped.

12.2.1 *Pre-Study*

Preparation tasks involve six areas: Collecting/defining user/customer wants and needs, gathering a complete data file of the project, determining evaluation factors scoping the specific study, building appropriate models and determining the team composition.

a) *Collect User/Customer Attitudes* — The user/customer attitudes are compiled *via* an in-house focus group and/or external market surveys. The objectives are to:
   1) Determine the prime buying influence;

PRE-STUDY

Collect User/Customer Attitudes
Complete Data File
Determine Evaluation Factors
Scope of the Study
Build Data Models
Determine Team Composition

VALUE STUDY

Information Phase
Complete Data Package
Modify Scope (if required)

Function Phase
Identify Functions
Classify Functions
Develop Function Models
Establish Function Worth
Cost Functions
Establish Value Index
Select Functions for Study

Creativity Phase
Create Quantity of Ideas by Function

Evaluation Phase
Rank and Rate Alternative Ideas
Select Ideas for Development

Development Phase
Conduct Benfit Analysis
Complete Technical Data Package
Create Implementation Plan
Prepare Final Proposals

Presentation Phase
Present Oral Report
Prepare Written Report

POST-STUDY

Complete Changes
Implement Changes
Monitor Status

FIG. 1 VE JOB PLAN

2) Define and rate the importance of features and characteristics of the product or project;
3) Determine and rate the seriousness of user-perceived faults and complaints of the product or project; and
4) Compare the product or project with competition or through direct analogy with similar products or projects.

For first time projects such as a new product or new construction, the analysis may be tied to project goals and objectives. The results of this task will be used to establish value mismatches in the Information Phase.

b) *Gather a Complete Data File* — There are both primary and secondary sources of information. Primary sources are of two varieties: people and documentation. People sources include marketing (or the user), original designer, architect, cost or estimating group, maintenance or field service, the builders (manufacturing, constructors, or systems designers), and consultants. Documentation sources include drawings, project specifications, bid documents and project plans.

Secondary sources include suppliers of similar products, literature such as engineering and design standards, regulations, test results, failure reports, trade journals and related internet websites. Another major source is like or similar projects. Quantitative data is desired.

Another secondary source is a site visit by the value study team. Site includes actual construction location, manufacturing line, or office location for a new/improved system. If the actual site is not available, facilities with comparable functions and activities may prove to be a valuable source of usable information.

c) *Determine Evaluation Factors* — The team, as an important step in the process, determines what will be the criteria for evaluation of ideas and the relative importance of each criteria to final recommendations and decisions for change. These criteria and their importance are discussed with the user/customer and management and concurrence obtained.

d) *Scope of the Study* — The team develops the scope statement for the specific study. This statement defines the limits of the study based on the data-gathering tasks. The limits are the starting point and completion point of the study. Just as important, the scope statement defines what is not included in the study. The scope statement must be verified by the study sponsor.

e) *Build Models* — Based on the completion and agreement of the scope statement, the team may compile models for further understanding of the study. These include such models as cost, time, energy, flow charts, and distribution, as appropriate for each study.

f) *Determine Team Composition* — The value study team leader confirms the actual study schedule, location and need for any support personnel. The study team composition is reviewed to assure all necessary customer, technical, and management areas are represented. The team leader assigns data gathering tasks to team members so that all pertinent data will be available for the study.

NOTE — All above stated aspects of pre-study may not be required for all value engineering projects. The team may decide as appropriate to their project.

12.2.2 *Value Engineering Study*

The VE study is composed of six phases: Information, Function, Creativity, Evaluation, Development, and Presentation.

a) *Information Phase* — The objective of the information phase is to complete the value study data package started in the pre-study work. If not done during the pre-study activities, the project sponsor and/or designer brief the value study team, providing an opportunity for the team to ask questions based on their data research. If a site visit (wherever applicable) was not possible during pre-study, it should be completed during this phase.

   The study team agrees to the most appropriate targets for improvement such as value, cost, performance and schedule factors. These are reviewed with appropriate management, such as the project manager, value study sponsor and designer, to obtain concurrence.

   Finally, the scope statement is reviewed for any adjustments due to additional information gathered during the information phase.

b) *Function Phase* — Function definition and analysis is the heart of value engineering. It is the primary activity that separates value engineering from all other improvement practices. The objective of this phase is to develop the most beneficial areas for continuing study. The team performs the following steps:

   1) Identify and define both work and sell functions of the product, project or process under study using active verbs and measurable nouns. This is often referred to as random function definition.
   2) Classify the functions as basic or secondary.
   3) Expand the functions identified in step 1) (optional)
   4) Build a function model — Function hierarchy/Logic or function analysis system technique (FAST) diagram.
   5) Assign cost and/or other measurement criteria to functions.
   6) Establish worth of functions by assigning the previously established user/customer attitudes to the functions.
   7) Compare cost to worth of functions to identify Value Gaps to establish the best opportunities for improvement.
   8) Assess functions for performance/schedule considerations.
   9) Select functions for continued analysis.
   10) Refine study scope.

c) *Creativity Phase* — The objective of the creativity phase (sometimes referred to as Speculation Phase) is to develop a large quantity of ideas for performing each function selected for study. This is a creative type of effort, totally unconstrained by habit, tradition, negative attitudes, assumed restrictions, and specific criteria. No judgement or discussion occurs during this activity. The quality of each idea will be developed in the next phase, from the quantity generated in this phase.

   There are two keys to successful speculation: first, the purpose of this phase is not to conceive of ways to design a product or service, but to develop ways to perform the functions selected for study. Secondly, creativity is a mental process in which past experience is combined and recombined to form new combinations. The purpose is to create new combinations which will perform the desired function at less total cost and improved performance than was previously attainable.

   There are numerous well accepted idea generation techniques. The guiding principle in all of them is that judgement/evaluation is suspended. Free flow of thoughts and ideas — without criticism — is required. Brainstorming is a technique popularly used in this phase.

d) *Evaluation Phase* — The objectives of the evaluation phase are to synthesize ideas and concepts generated in the creativity phase and to select feasible ideas for development into specific value improvement.

   Using the evaluation criteria established during the pre-study effort, ideas are sorted and rated as to how well they meet those criteria. The process typically involves several steps:

   1) Eliminate nonsense or thought-provoker ideas.
   2) Group similar ideas by category within long term and short term implications. Examples of groupings are electrical, mechanical, structural, materials, special processes, etc.
   3) Have one team member agree to champion each idea during further discussions and evaluations. If no team member so volunteers, the idea or concept is dropped.

4) List the advantages and disadvantages of each idea.
5) Rank the ideas within each category according to the prioritized evaluation criteria using such techniques as indexing, numerical evaluation, and team consensus.
6) If competing combinations still exist, use matrix analysis to rank mutually exclusive ideas satisfying the same function.
7) Select ideas for development of value improvement.

If none of the final combinations appear to satisfactorily meet the criteria, the value study team returns to the creativity phase.

e) *Development Phase* — The objective of the development phase is to select and prepare the best alternative(s) for improving value. The data package prepared by the champion of each of the alternatives should provide as much technical, cost, and schedule information as practical so the designer and project sponsor(s) may make an initial assessment concerning their feasibility for implementation. The following steps are included:
   1) Beginning with the highest ranked value alternatives, develop a benefit analysis and implementation requirements, including estimated initial costs, life cycle costs and implementation costs taking into account risk and uncertainty.
   2) Conduct performance benefit analysis.
   3) Compile technical data package for each proposed alternative:
      i) Written descriptions of original design and proposed alternative(s),
      ii) Sketches of original design and proposed alternative(s),
      iii) Cost and performance data, clearly showing the differences between the original design and proposed alternative(s),
      iv) Any technical back-up data such as information sources, calculations, and literature, and
      v) Schedule impact.
   4) Prepare an implementation plan, including proposed schedule of all implementation activities, team assignments and management requirements.
   5) Complete recommendations including any unique conditions to the project under study such as emerging technology, impact on other ongoing projects, marketing plans, environment and other social concerns, etc.

f) *Presentation phase* — The objective of the presentation phase is to obtain concurrence and a commitment from the designer, project sponsor and other management to proceed with implementation of the recommendations. This involves an initial oral presentation followed by a complete written report.

   As the last task within a value study, the VE study team presents its recommendations to the decision making body. Through the presentation and its interactive discussions, the team obtains either approval to proceed with implementation, or direction for additional information needed.

   The written report documents the alternatives proposed with supporting data and confirms the implementation plan accepted by management. Specific organization of the report is unique to each study and organization requirements.

12.2.3 *Post-Study*

The objective during post-study activities is to assure the implementation of the approved value study change recommendations. Assignments are made either to individuals within the VE study team, or by management to other individuals, to complete the tasks associated with the approved implementation plan.

While the VE team leader may track the progress of implementation, in all cases the design professional is responsible for the implementation. Each alternative must be independently designed and confirmed, including contractual changes if required, before its implementation into the product, project, process or procedure. Further, it is recommended that appropriate financial departments (accounting, auditing, etc), conduct a post audit to verify to management the full benefits resulting from the value engineering study.

13 ASSESSMENT OF VALUE ENGINEERING RESULTS

13.1 Firstly, all improvements in quality, productivity, competitiveness life, ease of maintenance, reliability (Mean time between failures — MTBF) and the like, should, by every possible means, be converted into monetary figures so as to compare:

P_1 : Cost before the VE study; and

P_2 : Cost after the VE study and by using any of the following methods.

13.1.1 *Method I — Simple Direct Calculation*

$(P_1 - P_2) \times Q$ where Q is the quantity manufactured per year, will give the annual benefit in rupees per year.

13.1.2 *Method II — Estimate Method*

Here, P_1 the cost before the VE study (which is a historical information) is replaced by P_3 the cost that would have been incurred had the product continued to be manufactured to the old design. It, therefore, takes into account the change in prices of labour and material, fluctuations in market demand, planned changes in production equipments or processes and such other factors as can be assessed with realistic accuracy.

$(P_3 - P_2) \times Q$ will then yield the figure of annual benefit.

13.1.3 *Method III*

In both cases above, the net benefit per piece can be expressed as a percentage, namely,

$$\frac{P_1 - P_2}{P_1} \times 100$$

$$\text{or} \quad \frac{P_3 - P_2}{P_3} \times 100$$

This is useful when the prospects of future VE activity are required to be assessed before approving additional VE studies.

13.1.4 *Method IV — Return on Investment Method*

$$[(P_1 - P_2)\,Q - S] : S$$
$$\text{or} \quad [(P_3 - P_2)\,Q - S] : S$$

where S is the cost of the VE study itself. It is usually expressed as a ratio. S will include costs of trials/development in addition to the cost of all human resource inputs.

13.1.5 *Method V — Overall Cost Benefit Ratio of the VE Cell*

Method IV relates to every single project. The aggregate of benefits and costs for all the VE projects implemented completely in a year can be compared to assess the effectiveness of the full time VE cell in the organization.

$\Sigma[(P_1 - P_2) \times Q] : C$ (where C represents the annual cost of the VE cell plus $\Sigma\, S$)

NOTE — In well organized VE work, this will often be more than 10 : 1.

13.1.6 *Method VI — Life Cycle Cost Method*

All the above methods are usually applicable easily to mass production items. Where VE is applied to building or project construction schemes, the benefits will be derived either in the initial capital cost of investment or in the annual costs of operation, maintenance and ownership or in both. The assessment of benefits will then involve the use of the principles of discounted cash flow (DCF) and the forecasting of inflation in future costs of labour, material and energy. For details of life cycle costing refer to IS 13174 (Part 2) : 1994.

14 ORGANIZATIONAL SET UP FOR VE ACTIVITY

14.1 Strength

Depending on the size and complexity of the organization, the VE department have to be established. It can vary from just one individual to 10 to 15 personnel at various levels in the corporate office together with 2-5 members at each manufacturing unit or division. The strength will depend obviously on the increasing success of VE operations and the extent of top management involvement and commitment to VE.

14.1.1 Annex C indicates the duties of the VE unit.

14.2 Place in the Organization

Desirably the head of the unit/department should report directly to the chief executive. In the initial stages, however, the VE manager can be a fairly senior person from the design, manufacturing R&D or materials departments. With the growth of VE results and staff, the VE unit can, at the appropriate time, be headed by a senior executive reporting directly to the chief executive. Properly organized, the VE chief will automatically be in the line of promotion to the topmost corporate levels (*see* Annex D).

14.2.1 The functions of VE review committee are indicated in Annex E.

ANNEX A

(*Clause* 3.7)

DIFFERENCE BETWEEN VALUE ENGINEERING AND COST REDUCTION

Sl No.	*Conventional Cost Reduction Techniques*	*Value Engineering*
i)	Item oriented	Function oriented
ii)	Tends to follow past practices and analytical	Applies innovative approach: a) Exercises maximum creativity b) No holds barred
iii)	Convergent Ideas	Divergent — Convergent Ideas
iv)	Cost visibility: 1) Part wise 2) Process wise 3) Material 4) Labour 5) Transport 6) Packaging 7) Overheads 8) Profits 9) Miscellaneous	Cost visibility: a) Function wise b) Basic function c) Secondary function d) Unnecessary function e) Unnecessary costs
v)	Usually individual oriented approach	Multidisciplinary team approach

ANNEX B

(*Clause* 10.6)

PROJECT SELECTION GUIDELINES

B-1 EXAMINE

B-1.1 Annual Materials Budget

B-1.2 Sales

Productwise turnover

B-2 CARRY OUT A-B-C ANALYSIS ON BOTH — PICK OUT 'A' ITEMS

B-3 Apply further the following tests; if the answer is 'yes' to three or more questions, the item is a good candidate for early VE.

B-3.1 Are there close and rigid machining tolerances?

B-3.2 High standards of chemical purity stipulated?

B-3.3 Is the design or process based on foreign collaboration?

B-3.4 Item is imported?

B-3.5 Uses high/special quality raw materials?

B-3.6 Are there too many parts? or

Too many operations involved? or

Very complex assembly? or

Too many linkages, radii, cambers? or all of these ?

B-3.7 How old is the design?

B-3.8 Are there many customer complaints?

B-3.9 Too many problems in production?

B-3.10 Severe competition? Sales are poor?

B-3.11 Was the present design developed as an emergency measure, though many years back?

B-3.12 Have you often felt that much can be done but never got round to do it?

B-3.13 Is rate of rejection too high?

B-3.14 Is the yield very low? In other words, finished product represents only a small percentage of original raw material (by weight or volume)?

B-3.15 Is the sum total of ideal costs of material, labour, overhead and profit, far less than the present actual costs?

B-4 The above procedure is particularly suitable for manufacturing or production areas involving high volumes of production. Since VE is also applicable to other areas, notably construction and software, guidelines regarding these are given below.

B-4.1 Construction Projects

All such one-time projects will invariably profit from upstream value engineering studies, that is, studies conducted at completion of 30 to 50 percent design stage. Unless an organization has several major projects going on simultaneously and all at the same stage of progress, the need for project selection as such will not arise as all of them must anyway undergo a value study. Even in mass production areas, new products proposed to be introduced in the production should be automatic candidates for value engineering studies whether or not the criteria given in **B-3** apply. Early value engineering studies in such cases are invariably far more productive than those carried out after production or construction has already commenced (*see* Fig. 2).

B-4.2 Soft Areas, Such as, Administrative Systems, Office Procedures, etc

Here the following criteria will apply.

B-4.2.1 Are there long delays in decision making?

B-4.2.2 Are too many people or channels involved in consultation and paperwork before a final decision can be taken?

B-4.2.3 Were studies conducted in the past to simplify and shorten the procedures but without significant success?

B-4.2.4 Is there a shared feeling that productivity, turnover, profitability, competitiveness, etc, are adversely affected under the present procedures? In other words, is there a general feeling among many people in the company that something ought to be done about the existing procedures?

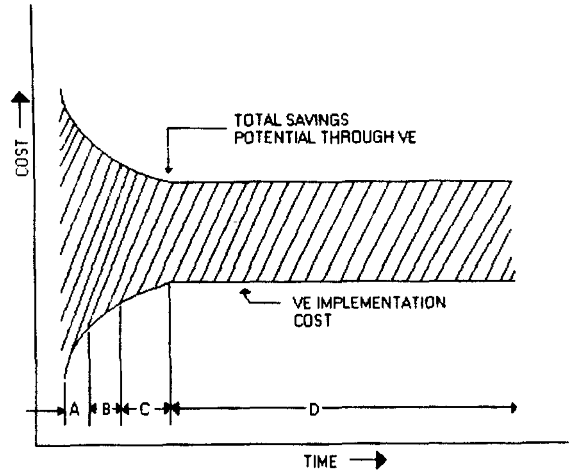
B-4.2.5 Is the present procedure several years old and has not been reviewed for a long time?

B-4.2.6 Was the procedure imposed by an outside agency or superior body, without adequate consultation with those involved who have to operate it?

B-4.2.7 Are you aware of better procedures existing elsewhere?

B-4.2.8 Is there too much of unproductive paperwork involved?

B-4.2.9 Are most of the papers prepared in several copies (4 or more)?



A — Conceptual and preliminary design phase
B — Detailed estimation and design phase
C — Production or construction phase
D — Operations and maintenance phase

FIG. 2 VE POTENTIALITIES IN LIFE CYCLE

B-4.2.10 Do only a very few of those who receive the copies actually need these?

B-4.2.11 Has the latest techniques of communication and automation being applied?

B-4.2.12 Have the areas amenable to computerization/IT been identified and changeover implemented?

If the 'YES' answers to these questions are three or more, then the system or procedure is a good candidate for an early value engineering study.

ANNEX C

(*Clause* 14.1.1)

DUTIES OF A VALUE ENGINEERING UNIT

C-1 Maintain up-to-date knowledge of the state of the art value engineering theory and practice.

C-2 Select specific projects for VE study and get them approved by management/customer and secure team members to perform the study

C-3 Lead and coordinate all VE studies.

C-4 Assist management in setting annual goals. Report monthly on progress on ongoing projects, projects completed and projects scheduled. Reports should demonstrate expenditures, namely, benefits, line item status of each project, educational programme status and return-on expenditure history.

C-5 Plan and conduct VE training courses to assure a cadre of basic trained personnel for studies.

C-6 Conduct management orientations and briefings as appropriate. Be available for similar briefings in VE for customers and clients.

C-7 Work with the procurement organization to involve vendors, suppliers and subcontractors in the VE programme. Develop methods of inviting their suggestions for value improvements and a sharing arrangement for those suggestions. Support procurement in any VE oriented change proposal negotiations.

C-8 Monitor the implementation of accepted VE proposals to assure maximization of potential benefits.

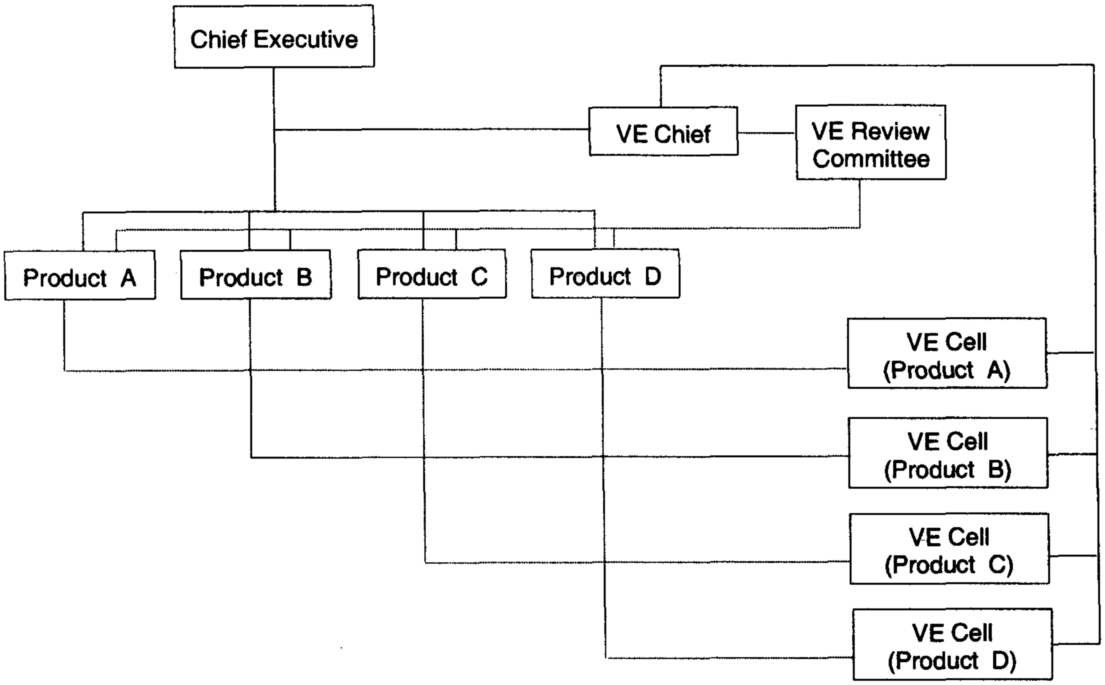
C-9 Represent the organization in the community concerning value improvement. Contribute to the VE profession's growth through participation in technical conferences, lecturing at colleges, etc.

ANNEX D

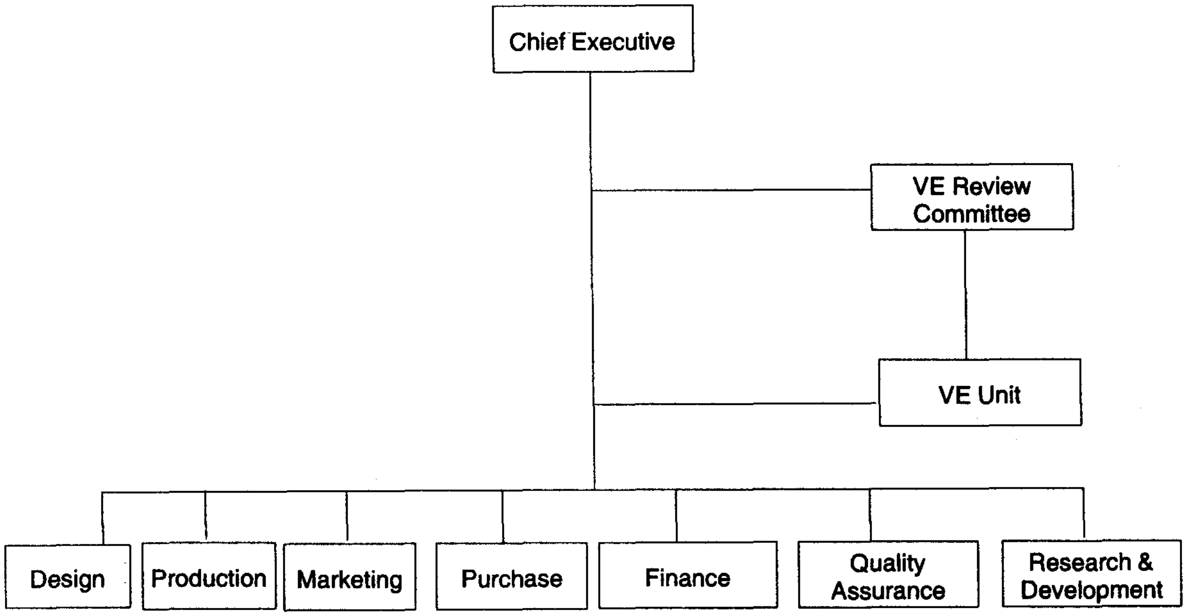
(*Clause* 14.2)

PLACE IN THE ORGANIZATION

Alternative 1 — For a large organization



Alternative 2 — For small or medium organizations dealing in a single product



ANNEX E

(*Clause* 14.2.1)

THE VE REVIEW COMMITTEE — OBJECTIVES AND METHODS OF FUNCTIONING

E-1 By definition, history and results, VE is a multi-discipline inter-departmental team effort; for such an effort to succeed top management support, involvement and guidance are essential. Hence the need for a top-level VE Review Committee.

E-2 It is composed of, usually, 3 to 5 members selected from among the heads of production, Design/R&D/Finance/Purchasing/Quality Control or other departments of a company and presided over by the chief executive.

E-3 The committee should meet at least once a month and review the progress and activities of each VE unit functioning in the organization. The VE Manager will act as the secretary to the committee and will place before them the status of each project.

E-4 Team leaders/coordinators concerning each project will attend the meeting and report to the review committee.

E-4.1 Progress Achieved

E-4.2 Results so far

E-4.3 Further Plans of Work

E-4.4 Future Targets

E-4.5 Problems Faced

E-4.6 Help Needed from the Committee

E-4.7 Funds Necessary

E-4.8 Other Relevant Points Concerning the Projects

E-5 The Committee will then provide suitable guidance and assistance to the teams to ensure the necessary inter-departmental coordination and in particular, to eliminate roadblocks. One of the most important functions of the Committee is to maintain and raise the morale and motivation of the teams by their wise and patient hearing as well as leadership and thus, to inspire the teams to high levels of creative achievement — a task in which the VE unit should also play a major role by correctly advising the review committee and suggesting possible courses of action.

E-6 The Committee will also consider and approve every new VE project, set annual financial targets for each project and for the VE units as a whole and interim targets also, wherever necessary.

E-7 In turn, the review committee will report to the chief executive. Perhaps, it could be best done at the time of the monthly production meeting held in each company or unit as thus, the chief executive can play a vital role of support to as well as involvement in, the VE activities under way in his organization. Alternatively, he can hold a meeting with the review committee specially and solely devoted to VE.

E-8 This procedure, therefore, assures the twin benefits of:

a) Motivating the teams as well as, and

b) Ensuring all necessary help to them in implementing the accepted VE proposals.

ANNEX F

(*Foreword*)

COMMITTEE COMPOSITION

Management and Productivity Sectional Committee, MSD 4

Organization	*Representative (s)*
Indian Airlines Ltd, New Delhi	Shri V. K. Jain (***Chairman***)
All India Management Association, New Delhi	Dr A. Sahay
All India Manufacturers' Organization, Mumbai	Shri Babulal Todi Shri Rajiv Chugh (*Alternate*)
Associated Chambers of Commerce and Industry of India (ASSOCHAM), New Delhi	Shri Avik Mitra Shri A. Roy (*Alternate*)
Bharat Electronics Ltd, Bangalore	Shri M. Mallaraj Urs Shri G. S. Dayakar (*Alternate*)
Bharat Heavy Electricals Ltd, New Delhi	Shri D. K. Sharma Shri P. K. Jindal (*Alternate*)
Central Building Research Institute, Roorkee	Shri G. C. Sofat Shri Ajay Singh (*Alternate*)
Deputy Directorate General of Management Studies, Ministry of Defence, New Delhi	Shri G. C. Jit
G. Management Services Pvt Ltd, New Delhi	Brig M. L. Garg Wing Cdr A. K. Dhingra (*Alternate*)
Glaxso Smith Kline Consumer Health Care Ltd, Gurgaon	Shri Pradeep Chaudhry Shri Deepak Gunvante (*Alternate*)
Hindustan Aeronautics Ltd, Bangalore	Shri V. P. Mathur Shri G. Prasanna (*Alternate*)
Indian Institute of Materials Management, New Delhi	Shri M. K. Bhardwaj
Indian Institute of Public Administration, New Delhi	Prof R. K. Sachdeva
Indian Institute of Technology, New Delhi	Dr J. M. Mahajan Shri A. D. Gupta (*Alternate*)
Indian Oil Corporation Limited, New Delhi	Shri Jai Gopal Shri V. K. Rai (*Alternate*)
Indian Statistical Institute, New Delhi	Prof Arvind Seth Prof S. S. Handa (*Alternate*)
Institute of Secretariat Training & Management, New Delhi	Shri K. P. Thomas Shri S. S. Yadav (*Alternate*)
Maruti Udyog Ltd, Gurgaon	Shri R. B. Madhekar Shri C. K. Joardar (*Alternate* I) Shri S. Bose (*Alternate* II)
Ministry of Defence — DRDO, New Delhi	Shri Rajwant Singh Shri Naresh Kumar (*Alternate*)
Ministry of Railways, Vadodara	Shri K. M. Thomas Shri S. C. Agnihotri (*Alternate*)
National Institute of Industrial Engineering, Mumbai	Prof Tapan P. Bagchi
National Productivity Council, New Delhi	Shri A. K. Vohra
Naval Headquarters, New Delhi	Cmdr Sheel Kant Lt Cdr R. Shukla (*Alternate*)
Ordnance Factory Board, Kolkata	Shri V. Gandhi Shri N. M. Seshadri (*Alternate*)
Peico Electronics & Electricals Ltd (PHILIPS), Mumbai	Shri P. S. Rao Shri E. R. Batliwala (*Alternate*)
Steel Authority of India Limited, New Delhi	Shri T. Tiwari Shri R. P. Singh (*Alternate*)
The Institute of Cost and Works Accountants of India, New Delhi	Shri M. K. Anand Shri D. C. Bajaj (*Alternate*)
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Member Secretary
Shri Praveen Khanna
Joint Director (MSD), BIS

Panel on Guidelines to Establish a Value Engineering Activity, MSD 4/P-8

Organization	*Representative (s)*
In personal capacity (*J-240, Sector 25, Jalvayu Vihar, Noida 201301*)	CMDE GURNAM SINGH (***Convener***)
Asea Brown Boveri Ltd, Faridabad	SHRI A. K. KASHYAP
Delhi College of Engineering, New Delhi	PROF S. K. GARG
Escorts Ltd, Faridabad	SHRI L. R. CHOUDHARY
Indian Institute of Technology, New Delhi	PROF PREM VRAT
National Institute of Industrial Engineering, Mumbai	PROF H. V. BHASIN
Naval Headquarters, New Delhi	CMDR GANESH MAHADEVAN
Ordnance Factory Board, Kolkata	SHRI S. S. BHATTACHARYYA SHRI S. K. DUTTA (*Alternate*)
Tata Quality Management Services, Pune	SHRI G. JAGANNATHAN

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